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US 4813762 A

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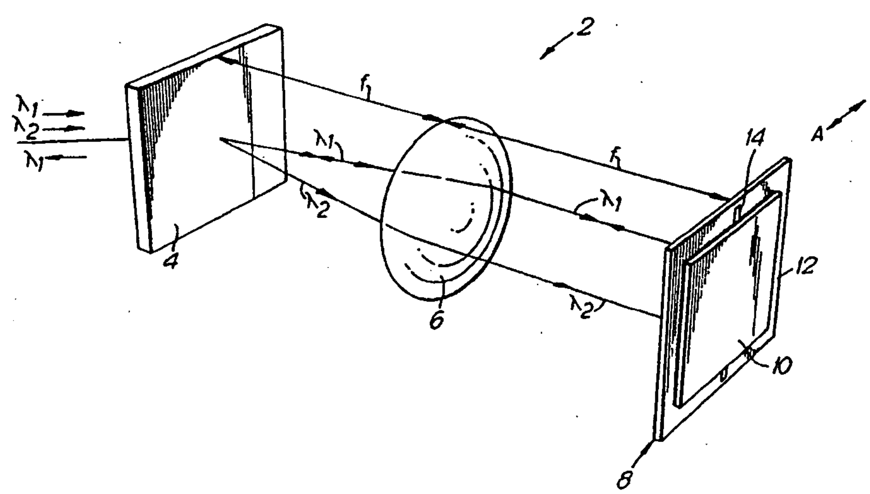
(54) **Reflection filter**

(57) A reflector filter has a transmission grating (4) and a microbead retroreflector screen (10) located behind a movable screen (12) having a slit (14). Radiation of the appropriate wavelength will strike the screen (10) through a slit (14) and is retroreflected back through the grating (4).



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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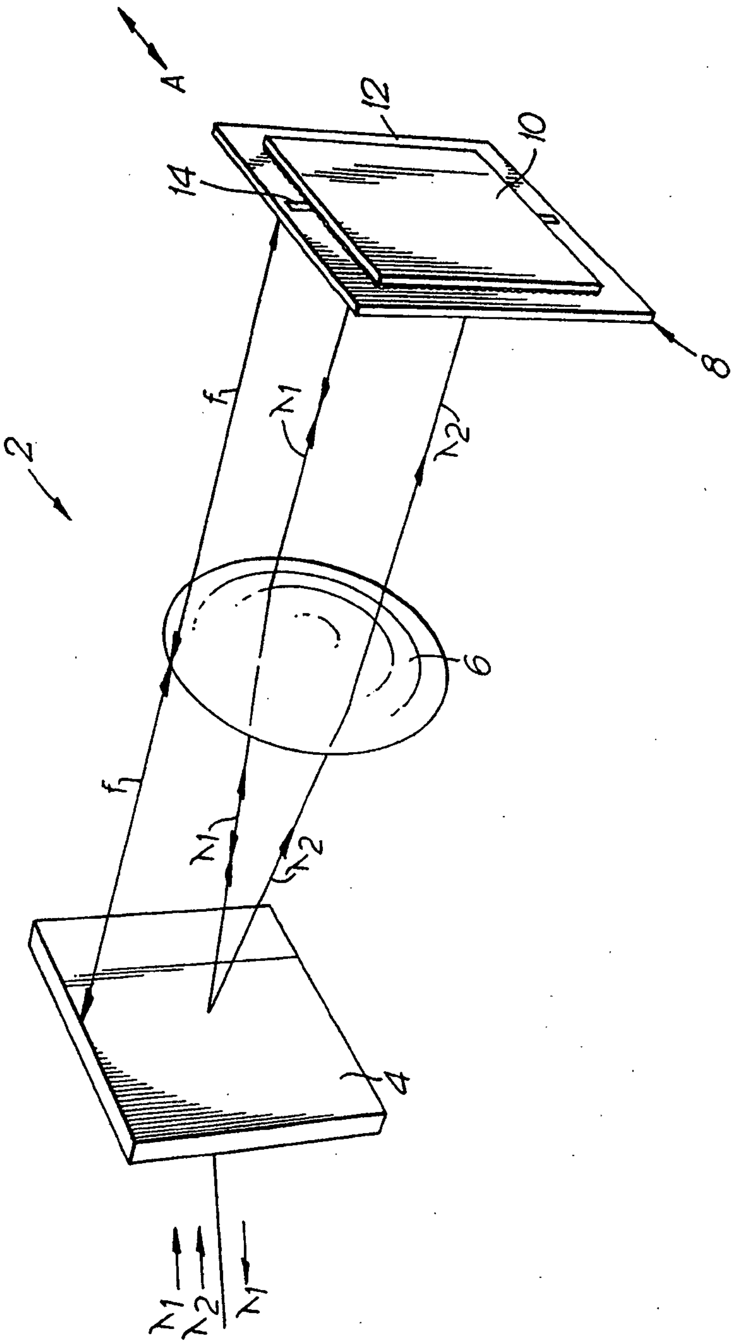

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REFLECTION FILTER

This invention relates to filters and in particular to filters employing a diffraction grating as a wavelength selective element.

There are many instances where an optical filter is required to select a band of wavelengths from a broader bandwidth source. For example, a reflection diffraction grating may be used to define the end of a laser cavity to selectively reflect back desired wavelengths of electromagnetic radiation along the cavity axis.

A paper by A.M. Hill and J.R. Stern titled "Advanced Optical Technologies for the Future Local Network" presented at the EFOC/LAN '89 Conference, Amsterdam June 12-16, 1989 (paper 2.2.3) describes a tunable optical filter in which light from an input single-mode fibre is collimated and angularly dispersed by a reflection grating to produce a spectrum of wavelength channels in the focal plane of a lens. A slit positioned in front of an output fibre in this plane can select a desired channel by moving either the slit or the input fibre with light passing through the slit being returned to the input fibre by a mirror behind the slit. The mirror requires accurate alignment and the use of surface relief gratings renders the efficiency sensitive to the state of polarisation of the input light.

According to the present invention a reflection filter comprises a transmission diffraction grating and a retroreflecting means for reflecting a portion of the

electromagnetic radiation passing through the grating and incident upon it back towards the grating.

The component wavelengths of electromagnetic radiation, for example optical radiation, incident on the transmission diffraction grating will be dispersed according to their wavelength. Only that portion of radiation which is then incident on the retroreflecting means will be reflected back towards the grating and be diffracted back towards the source of the electromagnetic radiation. The spatial extent of the retroreflecting means will therefore define which wavelength range or ranges of the electromagnetic radiation will be reflected, i.e. the bandwidth of the filter.

The filter preferably includes a converging lens system between the grating and the retroreflecting means to project the far field transform of the grating to the slit, i.e. make the grating appear at infinity. It additionally provides compensation for defects in the focal length of the elements making up the retroreflecting array.

The width of the retroreflecting means in the dispersion plane defines the bandwidth of the electromagnetic radiation reflected back, and hence selected. The retroreflecting means may comprise a strip of a retroreflecting elements fixed to a non-reflective support or a larger width of retroreflecting elements in front of which is positioned a screen having a slit of the desired width. The width of the individual retroreflecting elements should be smaller than the slit width for maximum efficiency.

The filter may be made tunable by mounting the retroreflecting means for lateral movement with respect to grating. In the case of a strip of retroreflecting elements, the stip can be made moveable relative to the grating. In the case of screen with a slit, moving the screen will move the position at which retroreflection will occur. In this latter case the screen and retroreflecting elements may be moved

together if more convenient. The slit may be in the form of a liquid crystal display screen with controllable slitter piscels.

An embodiment of the invention shown as a schematic end view in the accompanying Figure 1 will now be described by way of example only.

The reflection filter 2 comprises a volume phase hologram transmission diffract grating 4, a convex lens 6 and a retro-reflection means 8 comprising a microbead reflective screen 10 and a non-reflective screen 12. The screen 12 has a slit 14 through which electromagnetic radiation can pass to be retroreflected by the retroreflective screen 14.

The grating 4 is formed in gelatin in a known manner having 600 lines/min is 20?m thick and 2cms square. A volume phase hologram is preferred as it has high efficiency but other transmission gratings are applicable to the present invention.

The screen 10 is formed from a microbead screen sold under the trademark "Scotchlite" and called "7610 high gain sheeting" by the manufacturers 3M Inc. Other retroreflective elements may be used.

The width of the slit 14 defines the bandwidth of the electromagnetic radiation which is retroreflected. The filter may be tuned by moving the whole retroreflecting means 8 laterally in the direction or moving the screen 12, only, leaving the retroreflective screen 10 fixed in position relative to the grating 4 and lens 6.

The lens 6 of focal length f is positioned such that the grating 4 and the front surface of the microbead screen 10 are each distance f from the lens so as to generate the far field transform of the grating and to improve retroreflection.

Tuning is also achievable by rotating the whole filter 2 with respect to the source of radiation (not shown), for example the resonant cavity of a laser.

The present invention may also be used as a notch filter

for removing a particular band of wavelengths from electromagnetic radiation incident on the grating 4 by exposing all but a strip of the retroreflective screen 10 to the incident radiation. Wavelengths other than those incident on the strip will than be reflected back towards the source.

Similarly a cut-off filter can be made by allowing all wavelengths up to a cut-off wavelength impinging on the retroreflective screen.

CLAIMS

1. A reflection filter comprising a transmission diffraction grating and a retroreflecting means for reflecting a portion of the electromagnetic radiation passing through the grating and incident upon it back towards the grating.

2. A filter as claimed in claim 1 in which the retroreflecting means comprises a microbead retroreflective sheet.

3. A filter as claimed in claim 2 in which the retroreflecting mean further comprises a screen having a slit positioned between the retroreflective sheet and the grating.

4. A filter as claimed in claim 3 in which the screen is movable laterally relative to the grating.

5. A filter as claimed in any preceding claim including a converging lens between the grating and the retroreflecting means.

6. A reflection filter as hereinbefore described with reference to the accompanying drawings.

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